# A NOTE ON THE GEOLOGY OF THE COSO RANGE, INYO COUNTY, CAL.

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The completion of the geological history of the Sierra Nevada and associated ranges appears to rest, for practical reasons, upon the determination, at different times and in different places, of the necessary facts. It is with this in mind that the writer presents the following data, ascertained on a recent short business trip. It is hoped that others may be fortunate enough to be able to dig more deeply into the rocks, both in the locality described and elsewhere in the adjacent regions.

The Coso Range lies between the Sierra Nevada on the west and the Darwin or Argus Range on the east, separated from each by a long narrow valley. At the north end the Coso Range forms the south boundary of Owens Valley, and extends thence southerly along its main axis for about forty-five miles. The greatest width at the north is twenty miles (see map, Fig. 1). A number of general statements have been made regarding this peculiar range, with but little in detail.

From whatever point of view seen, the Coso Range is strikingly different in appearance from the surrounding mountains. Fig. 2 shows the Range looking south from Keeler. The typical appearance is here well outlined. The flat, nearly horizontal, sky line, with, in general, gentle slopes to the bordering valleys, give an air of maturity not found in the precipitous fault scarps of the Basin Ranges. One comparatively small scarp is seen in the eastern part of the range, facing northeast, and its supplementary scarp occurs in the western portion. The form of the whole is that of a very flat elliptical dome, with its longer axis lying north and south. The periphery of this dome grades into the surrounding valley alluvium. The northern and western flanks are largely covered with basalt flows; the eastern

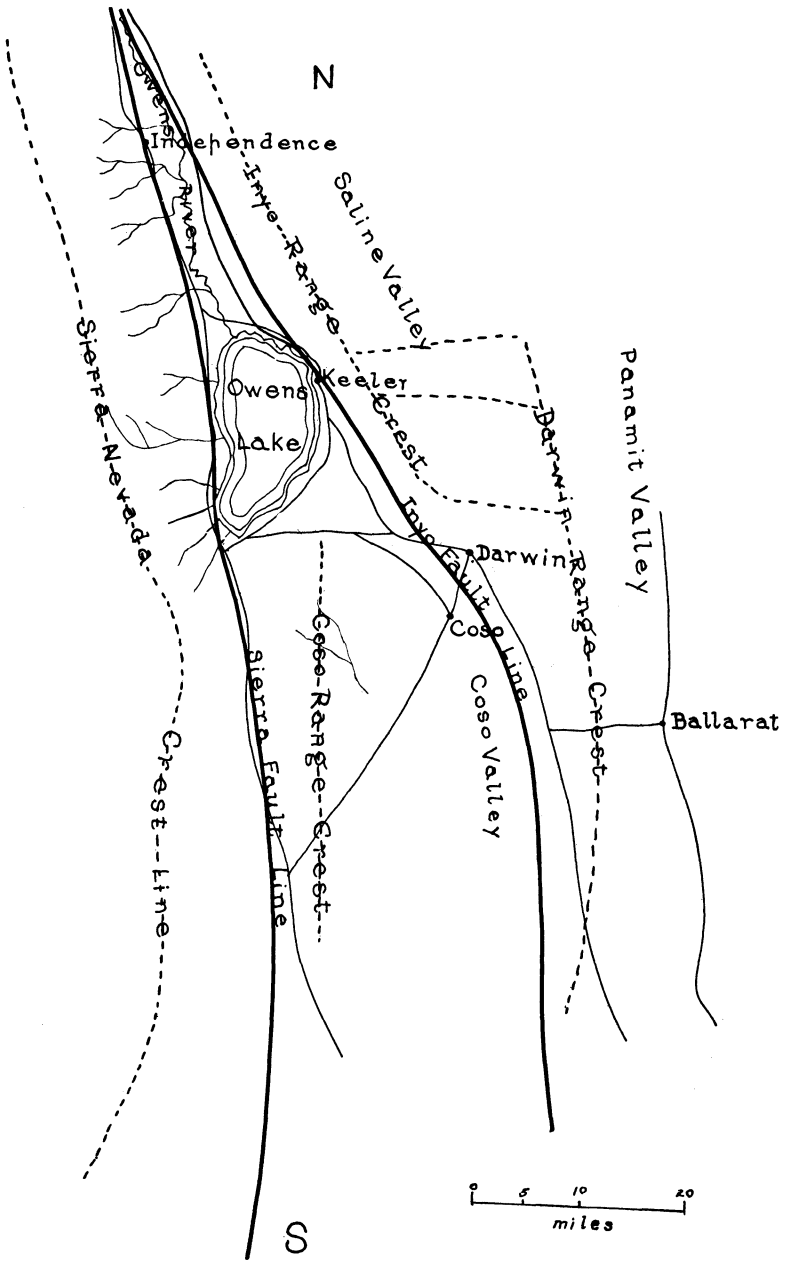


FIG. 1.—Sketch map of region surrounding the Coso Range.

side, facing Coso Valley, is free from these late volcanics. From Darwin, elevation 4,746 feet, on traveling westward, there comes first a long alluvial slope of about five miles, with small granite knobs and low hills rising slightly above the surface. Fig. 3 gives a view south of Darwin, showing a long eastern spur of the Coso Mountains which extends sufficiently far to show the effects of the faulting along the Coso Valley line. The contrast between the low granite hills and the fault topography of the Darwin Range is very evident.

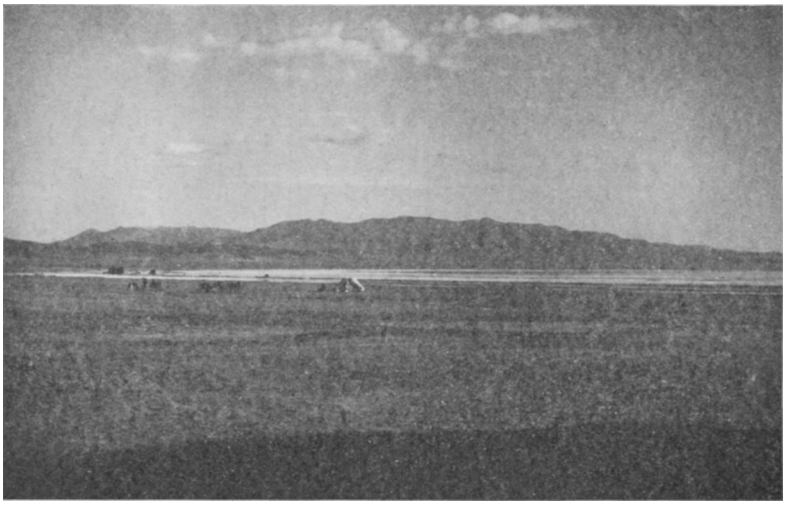

FIG. 2.—View of Coso Range looking south from Keeler. Shows east-west profile of range and east fault scarp. The low basalt ridge connecting the Coso and Inyo ranges is seen at left.

From the upper edge of the alluvial apron, an elevation of 5,200 feet, the granite rises gradually westward for 2 miles to the foot of the fault scarp shown in Fig. 2, at an elevation of approximately 5,500 feet. Above this base the range rises about 1,900 feet. The fault scarp itself is less than 1,000 feet, though originally it may have been much more. From the east fault the east-west profile of the range is well shown in Fig. 2, with the gradual merging of the dome into the western valley. The north-south profile, see Fig. 4, is similar, with Coso Peak as the center and highest point. The present

height and character of Coso Peak are due in part to faulting; probably it is also near the original center of the granitic dome.

The granitic slopes descend on the east and disappear beneath the alluvial apron. But there are several important facts to be noted concerning this. In the slopes just west of Darwin the alluvium is deeply trenched by present wet weather streams. This trenching varies from a few feet in Coso Valley (see Fig. 3) to 75 feet or more in the low hills. The same dissection of alluvial aprons and fans is

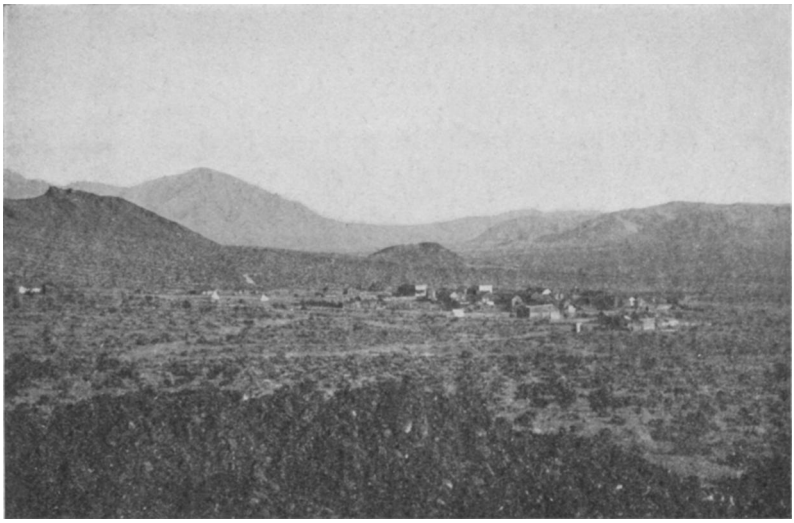

FIG. 3.—View south over Darwin, showing low Coso hills at right, and fault topography of Darwin Range to left. Wet-weather stream wash in middle distance over Darwin.

found along the east base of the Sierra Nevada as far north at least as Carson City, Nev., and indicates a widespread climatic change. The conditions of large, heavily loaded torrential streams have been replaced by those of small, lightly loaded wet-weather ones.

In the Coso hills the stream gullies, locally termed washes, have exposed the nature of the material lying upon the granite. The surface layer is a coarse, angular, granitic sand, showing no traces of water action. That lying lower, on the crystalline base, varying in thickness from ten to thirty feet where seen, is stratified, and dips

very gently to the east. These beds are water-laid granitic sands of finer grain than the unsorted stuff above. They average six inches in thickness.

These water-laid strata might excite little more than passing notice were it not for the fact that they belong to an extensive formation. In traveling to Darwin from Keeler the road traverses the beds of the present lake to the north edge of the basalt flows shown in Fig. 4. The older Owens Lake cuts a small cliff in the volcanic about 150

FIG. 4.—View of Coso Range looking southwest from high end of Inyo Range. Basalt ridge in right center rests on lake beds at south edge, and is notched by older Owens Lake on north. Basalt shows much faulting. The white area south of basalt ridge is composed of lake beds with some recent alluvium. Coso Peak in left center, snow capped. Sierra Nevada—on extreme right.

feet higher than the present water level. Three well-formed beaches are preserved, with a number of smaller imperfect ones. Southward the basalt is found lying upon rather coarse sands stratified poorly at the top and well bedded below. These beds are granitic where examined, with traces of volcanic ash. Some finely stratified fine-grained beds occur in the lower part of the formation near the center of the valley, which seem to contain considerable ashy material; also some few small pebbles of schist and finer detritus of like nature

are found, but no such rocks were noted in place. The greatest thickness of the beds is about two hundred feet, with the base not exposed. In areal extent they persist from the basalt ridge on the north (see Fig. 4) to a low easterly spur of granite about eight miles north of Darwin. From this ridge southward the beds were not seen except in the exposures west of Darwin. The highest elevation is on the low granite spur, 60 feet above the bench mark of the U. S. Geological Survey marked elevation 5,101 feet. Here the section

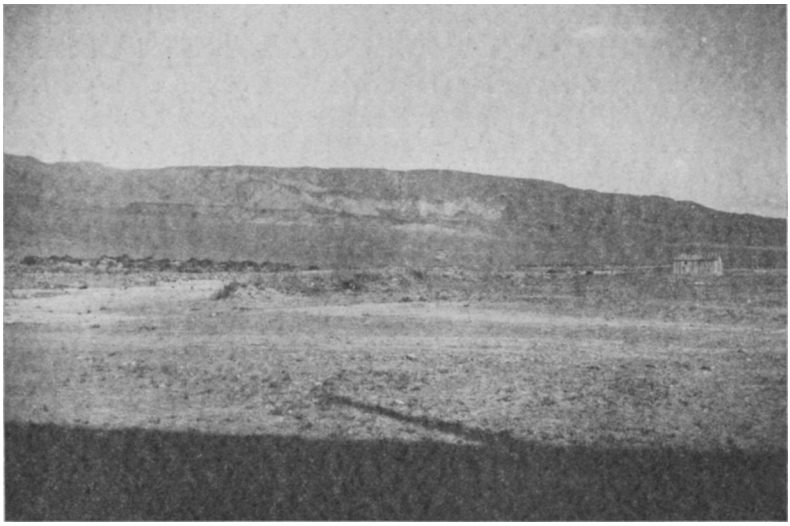

FIG. 5.—Basalt-covered low south end of Inyo Range, looking southeast from Keeler. Shows the intense faulting of the late basalt flows resting on the old sedimentaries and Tertiary lake beds low down.

is small but complete. On the crystalline base, nearly horizontal, is roughly one hundred feet of well-stratified granitic sandstone, with one foot of reddened material at the top, overlaid by basalt. There is a slight northerly dip. Just south of the point of greatest elevation the stratified rock lies horizontal at a lower elevation.

In the basalt-covered portion of the low south end of the Inyo Range similar arenaceous beds are burned by volcanic flows (see Fig. 5). East of Keeler, above the deposits of the older Owens Lake, occurs a large amount of sand, which may, and probably does, repre-

sent a northerly continuation of the same beds. In general these beds dip slightly to the north; locally they are either gently folded, or broken and faulted near the basalt flows. The lowest elevation of their exposures is 3,760 feet, south of Keeler; the highest is 5,160 feet, nearer Darwin. This gives a vertical range of at least 1,400 feet and a height above the present lake of 1,560 feet. Lake beds are noted by Fairbanks,[1] occurring on the west flank of the Coso Range, which correspond in elevation with those on the east. These lake deposits probably extended northward and joined with those of Wancobi Lake of Walcott.[2] Spurr[3] has given a brief résumé of the existing knowledge of these, and concludes that no local faulting has been the cause of the elevation of the Wancobi beds. In the Coso strata many small faults have occurred, but it is very doubtful if their present position is due in the main to differential motion of the underlying rocks. If this be so, it is entirely probable that one large lake existed over this region, as Spurr[3] concludes, which was drained by tilting north and south from a point in the vicinity of Mono Lake. At this latter locality the beds are at elevation 7,100 feet; at Wancobi embayment 7,000 feet; and near Darwin at 5,200 feet. These figures would indicate a differential tilting, which combined with the fact of much faulting of the basalt overlying the lake beds southeast of Keeler (see Fig. 5), makes it very probable that local elevation in the Inyo Range has caused a part of the present elevation of the lacustrine formation.

A further point noted in the stream gullies west of Darwin is that the granite, though showing no faults of size, is intensely fractured as if squeezed between powerful jaws. The complexity of these small movements is well shown by the quartz veins, which are most intricately displaced in small blocks. The prevailing mode of this displacement consists of a series of northeast-southwest faults dipping northerly, along which the north walls have moved westward. The best-developed joints strike N. 40 W. with a dip of 85° northeast. The rocks are deeply weathered, with the surface covered by rounded boulders of disintegration.

[1] *American Geologist*, Vol. XVII, p. 69.

[2] *Journal of Geology*, Vol. V, pp. 340–48.

[3] *Bulletin 208*, U. S. Geological Survey, pp. 209, 210.

Of the rocks themselves no detailed petrographic investigation seems to have been made. The various writers have described them as granitic, with basalt flows north and west. The granite of the dome has the characteristics of the intrusive granodiorite of the Sierra Nevada, and ranges from a basic hornblende-biotite granite to a diorite. Traces of an older basic diorite are included in the normal facies. A few dark-colored basic dikes and a great number of pegmatite dikes also occur. Dikes of diorite-porphyrite are found, striking in general north and south. These are frequently andesitic in character. The basalt flows are agglomeratic at the base, grading upward to massive, often vesicular, at the top. Some of the earlier mud flows picked up considerable sandy material from the lake beds. The quartz veins are small and in two series, of different ages and characteristics in the localities visited. The older veins strike northwest and southeast and bear evidence of having been formed at great depths, the present veins being but the roots of the original ones. The gangue is quartz, with strong alteration of the granite walls. This alteration is shown by the development of large plates of biotite and the recrystallization of the constituents of the grano-diorite for a short distance from the vein. The ores are pyrite and chalcopyrite, carrying some gold. The later quartz veins strike northeast and southwest. The granite near the veins is metasomatically replaced by silica at times. The ores are pyrite, chalcopyrite, sphalerite, galena, sulphantimonides of silver and lead, and finely divided free gold rich in silver. These veins are connected genetically with the intrusions of the diorite-porphyrite, as seen in exposures studied in the Inyo Range to the north.

The Coso Range is peculiar in that its line of evolution did not wholly follow those of the surrounding ranges. The first uplift was simultaneous with the intrusion of the Sierra Nevada batholith, after which it was probably a range of great height and geographic importance. It must at that time have formed a southeast extension of the older Sierra Nevada, though probably as a distinct range underlaid by an intrusive granitic dome. The overlying sedimentaries were removed almost entirely by erosion before Tertiary faulting broke a long stable condition of the crust and formed lake basins along the east flank of the Sierra. The lines of this faulting were such

that the Coso Range became a very distinct unit, one main fault going to the west and forming the east wall of the Sierra, another passing to the east and forming the west wall of the Darwin Range (see Fig. 1). The large lake in which the Wancobi and Coso beds were deposited was formed at this time, and granitic detritus deposited from the Coso Mountains in the arm north of Darwin. The occurrence of the few fragments of schist indicates that the last remains of the older rocks in the body of the range were removed just previous to, and in part coincident with, the draining of the lake. The only locality where the older rocks yet remain is in an east-west ridge about eight miles north of Darwin and just east of the low granite spur noted above as marking a south limit of the lake beds. On this east-west ridge of older rocks is exposed a magnificent section about a mile thick, the strata dipping uniformly east at about 45°. No time could be given to an examination of these rocks. The older lake basin was eventually drained by further movements along the fault planes, and basalt eruptions covered the west and north flanks of the Coso Mountains, the south end of the Inyo Range, and a large area of the lake beds south of Keeler. As some of the basalt lies upon unstratified sands which are above the lake strata, the lake must have been partly drained previous to the initiation of the volcanic flows.

Still later faulting along the old lines produced further elevation of the Inyo Range and differential movements of the lake beds along this sierra. Through it all the Coso Range was faulted only by small displacements, caused by its position between the two great converging faults to east and west. Thus these comparatively insignificant mountains stand as a monument of the older geologic time when the western cordillera was composed of low mature ranges not characterized by the excessive and great faulting seen today.